5.0 POTENTIAL APPLICATIONS

This chapter discusses potential applications of videotape technology in HOV lane surveillance and enforcement in the light of the field test findings. Issues of cost-effectiveness and public attitudes are addressed, and future research directions are identified.

5.1 ENFORCEMENT APPLICATIONS

Videotape can be used to support HOV lane enforcement in at least two ways:

1. **On-Line Assistance.** Video cameras can serve as enforcement eyes, identifying and recording the identity of potential violators who are then pursued and cited by officers located downstream from the control monitor.

2. **Remote Ticketing.** Videotape records might potentially be used to trigger a system of mailed warnings or citations, reducing the need for on-line enforcement.

5.1.1 On-Line Assistance

The use of videotape as an on-line enforcement aid appears to be somewhat limited. An officer stationed beside an HOV lane in an enforcement area is in a better position to observe violators than an officer stationed in the control van watching a video monitor. Furthermore, the roadside presence of an officer in an enforcement area can have a cautionary effect on drivers. Both officers can radio ahead to pursuit units and are likely to see far more violators than a team of two pursuit units can handle (larger enforcement teams are likely to cause rubbernecking and traffic breakdowns).

The only locations where an officer in the videotape van might be better able to assist on-line enforcement than an officer on the freeway would be those locations where there is no refuge area adjacent to the HOV lane. If there is no median shoulder or enforcement area where an officer can be situated for enforcement purposes, video-assisted enforcement stops might make more sense. The Marin 101 HOV lane is a good example of such a location. In the previous test of enforcement tactics on Marin 101, it was virtually impossible to find an adjacent location where a motor officer could safely observe traffic (Billheimer, 1990).

5.1.2 Remote Ticketing.

From an enforcement standpoint, the real promise of videotape is its potential use as a triggering mechanism for a system of mailed warnings or citations. The successful implementation of such a system could save officer time, reduce the number of hazardous pursuits needed to apprehend HOV lane violators, and improve traffic flow by eliminating much of the rubbernecking which follows ticketing activities during peak commute hours.

How It Might Work. If such a system were implemented, a four-camera set-up could be used to document HOV lane use. Videotapes of peak commute hours would be screened by trained observers, the license plates of violators would be noted, hard photographic copies documenting the violation would be produced, and warning letters or citations would be mailed to the registered owner of the violating vehicle. Photographic evidence of the violation would not be forwarded to the vehicle owner. However, this evidence would be available in the event that the citation is appealed in court.

Although California cannot currently issue warnings or tickets by mail to registered owners, a few states have instituted such procedures.* Exhibit 5.1 contains a copy of the letter sent to Seattle drivers as part of that city's HERO program to discourage the illegal use of HOV lanes.

Implementation Problems. A number of hurdles need to be cleared before HOV tickets by mail could become a reality in California. These include:

1. Demonstration of the technical feasibility and accuracy of videotape as an enforcement tool;
2. Clearing of the legal impediments to citing the registered owner of a vehicle by mail;
3. Consideration of the public information issues associated with a ticket-by-mail campaign and the campaign's impact on the public acceptance of HOV lanes.

* Two such states are Washington and Virginia. Seattle has relied on other drivers for descriptions of violating vehicles as part of their HERO program (Reference, 1). Virginia relies primarily on the observations of police officers in identifying violators who are sent citations through the mail (Tollett, 1990).

EXHIBIT 5.1

WARNING LETTER TO SEATTLE DRIVERS

JOHN SPELLMAN
Governor

DUANE BERENTSON
Secretary

STATE OF WASHINGTON
DEPARTMENT OF TRANSPORTATION
Office of District Administrator D-1, 6-131 Corson Ave. So., C-81-110 . Seattle, Washington 98 108

Date

Name
Address
City, State, Zip

Dear:

At approximately time on date your vehicle, license number ORH606 was observed in violation of-the bus/Carpool lane restrictions on Location.

State law restricts usage of these lanes to buses, motorcycles or vehicles carrying three or more persons. This restriction is in effect 24 hours a day. If your vehicle la observed again in violation of the bus/Carpool lane restrictions, the State Patrol will be notified.

We are concerned with the unauthorized use of the bus/carpool lanes.

More new freeways cannot be built because of high cost. environmental factors, and land consumption. Therefore, alternative means of travel must be found to relieve present congestion and to accommodate future growth in the Seattle area.

The bus/carpool lanes increase the people-moving capacity of Interstate 5. Running at only a quarter of their capacity. the bus/carpool lanes carry 2700 people in the peak hour. The other lanes each carry 2200 people in four times as many vehicles and run virtually at capacity.

Because there are fewer vehicles in the bus/Carpool lanes, speeds are higher than in the ocher lanes. Higher speeds provide the commuter with a shorter travel time -- an incentive to Carpool or take a bus. Each time someone shares a-ride. everyone benefits since fewer vehicles are competing for space in the other freeway lanes.

If you did not violate the bus/carpool lane restrictions or would like to discuss the bus/carpool lanes or our actions, please call me at (206) 764-4376.

Sincerely,

Traffic Systems Management
Washingeon State Department
of Transportation

This study has focused on the first aspect, the technical feasibility and accuracy of videotape as an enforcement tool. Legal issues are beyond the study scope, as are public information concerns, which are addressed briefly in a later section.

Based on field test findings to date, videotape technology by itself does not appear to be sufficiently accurate for use in a system of mail-out warnings and citations. Although the technology is capable of providing accurate views of vehicle windows and license plates when traffic is moving at top speed, and certain offenses (i.e. illegal buffer crossings) can be unambiguously recorded on tape, the false-alarm rate caused by children and adults out of camera range is too great to support citations for occupancy violations.

The problem of accuracy is further exacerbated by the need to deal with ambient lighting. As a day's shooting progresses, the movement of the sun can cause the view provided by a particular camera to be obscured by glare or to lose definition. Filters and aperture adjustments can sometimes overcome these problems, but camera crews need to remain alert to make such adjustments.

Promising Configurations. Although videotape by itself does not appear to be accurate enough to provide a basis for citations, the combination of videotape and an observing officer could conceivably provide the accuracy needed for a system of mailed warnings and citations. Such a system could work in much the same way as the recent field tests. That is, an officer would be posted far enough downstream from the video cameras to verify the occupancy of suspect vehicles and identify violators who escaped the notice of observers in the control van. Warnings or citations would be mailed only to vehicles which were identified as violators by the observing officer and by a review of the videotape.

This process is not foolproof, since it is possible that the observing officer could fail to see a child or sleeping adult who also escaped the notice of the camera's eyes. However, such mistakes should be relatively rare, and the officer would have the videotape record to back up any required court testimony. The proposed procedure also fails to free officers entirely from special overtime assignments to HOV lane enforcement. However, a single officer used in conjunction with a videotape set-up should be able to identify nearly all of the violators passing both the video camera and the officer's observation post. This would result in the issuance of far more citations than the officer could possibly write on his own. Furthermore, a mail system would eliminate the need to pursue and cite violators during rush hour, thereby improving officer safety and reducing congestion caused by rubbernecking.

Future Research Needs. Future videotape research should explore the use of four camera views in an enforcement setting. Although the current research experimented with four views, the most promising combination of views (long shot of oncoming vehicles, oblique view of passenger seat, eye-level view of rear seat, and downward shot of license plate) was never tested.

Future research should also test the concept of mailed warnings by using the combination videotape and observing officer to identify violators. Lane activity should be monitored on several successive days, warnings should be mailed to suspected violators (i.e., violators identified by both the officer and videotape reviewers), and the impact on freeway violations and public response should be monitored. By using videotape to monitor HOV lane operations in this fashion, it should also be possible to develop a better understanding of the incidence of repeat violators on violation totals.

Other uses of videotape technology should also be explored. For example, a micro-camera installed in the helmet of a motorcycle officer could document vehicle occupancy at the same time that the officer does. The camera would provide a record of both vehicle occupancy and driver identity, and could even document the license plate as well. If the legal obstacles to mail-out tickets could be overcome, the micro-camera could provide a videotape record in support of a mailed citation. This would make it unnecessary for officers to pull vehicles over during commute-hour traffic, thereby improving their efficiency and avoiding the congestion resulting from rubbernecking.

Virginia has established a system of mail-out warnings based on the visual observation of officers (Tollett, 1990). However, registered owners are currently able to escape prosecution by claiming they weren't driving their vehicle or asserting that a small child was aboard at the time. A videotape record provided by a micro-camera could counter this line of defense.

5.2 PERFORMANCE MONITORING

Although videotape systems do not currently appear to provide enough accuracy to support occupancy citations, there are several applications for which such systems are ideally suited and provide a marked improvement over current practice. These include:

1. **Freeway Monitoring** to document vehicle type and occupancy over time.

2. **HOV Lane Monitoring** to document occupancy rates as an aid for enforcement planning; and

3. **Project Evaluation** to document the impact of HOV lanes and other carpool incentives on occupancy rates.

5.2.1 Freeway Monitoring

The task of documenting vehicle occupancy and vehicle type in monitoring freeway performance over time is new to most operating agencies. In many areas of California, there are no historical records of vehicle occupancy rates which can provide a basis for tracking carpool trends or assessing the likely impact of proposed carpool incentives. With the increased emphasis on air quality control and ridesharing, it is important that freeway operations personnel begin to document not only the number of vehicles using freeway segments, but also vehicle mix and occupancy levels. Current tests suggest that video cameras can provide a more consistent and accurate record of vehicle occupancy rates than roadside counters. Moreover, the tape supplies a permanent record of freeway activity which can be consulted long after the initial counts were made.

5.2.2 HOV Lane Monitoring

Intelligent planning of HOV lane enforcement requires, at a minimum, annual monitoring of violation rates so that appropriate levels of overtime enforcement can be allocated. This is especially important in the case of ramp meter bypass lanes, which rely almost exclusively on special overtime enforcement. Recent experience in California suggests that monitoring activities have fallen behind or been set aside as bypass lanes have proliferated. Video surveillance provides a technique for obtaining and maintaining consistent and accurate records of the use of ramp bypass lanes and other HOV facilities for planning purposes. Furthermore, this availability of license plate data can identify the incidence of repeat violators. The permanent record provided by the videotape can also help to silence skeptics who challenge figures cited in support of HOV lane operations.

5.2.3 Project Evaluation

Objective evaluation of HOV projects requires careful measurement of vehicle occupancies before and after the installation of a new HOV lane. If proper occupancy measurements are not made (or are made inconsistently) before a lane is installed, the lane's impact can never be documented adequately.

Even if many manual counts are made, the inconsistencies of individual counters can color results. On the Santa Monica Diamond Lanes, for example, one observer responsible for counting vehicle occupancies before the lanes were installed consistently understated the number of vehicle occupants. When this observer was replaced following the lane installation, subsequent counts showed steep (but overstated) carpooling increases (Billheimer, 1978). Similarly, early occupancy counts on the separate HOV lane on San Diego l-15 proved to be inaccurate because one particular observer consistently understated violation rates. The use of videotape records provides a consistent and verifiable approach to documenting occupancy rates before and after the installation of an HOV project.

5.3 UNIT COSTS

5.3.1 Equipment

Purchase Cost. The cost of outfitting a van with four color cameras capable of recording HOV lane activity at the same level of detail as the field tests documented in this study is estimated to be $108,000. Exhibit 5.2 itemizes the individual components of this cost. The largest components are the van itself ($36,000), three U-Matic three-quarter-inch video recorders ($14,500), four high-speed color cameras with telephoto lenses ($10,800), a special effects generator ($1 O,OOO), and California sales tax ($6,828).

Contracting/Licensing Costs. For jurisdictions which do not have sufficient surveillance needs to invest in a fully equipped van and train personnel to record and reduce data, ATD Incorporated has set the cost of videotaping a peak period of HOV lane activity at $5,000. This price includes the use of the equipment listed in Exhibit 5.2, along with the services of trained operators. It does not, however, include the costs of reducing the videotaped data.

EXHIBIT 5.2

HOV VIDEO VAN COST ESTIMATE

Item	Description	Qty	Cost	Extended
01	Motor Van with Toilet and Cab-bed	1	$36,000.00	$36,000.00
02	Air Conditioner	1	1,500.00	1,500.00
03	Motor Generator (4Kw)	1	2,500.OO	2,500.OO
04	Awning	1	2,000.00	2,000.00
05	Trailer Hitch	1	350.00	350.00
06	Custom Equipment Racks	1	2,000.00	2000.00
07	Mobile Phone	1	1,500.00	1,500.00
08	Emergency Light/Generator	1	800.00	800.00
09	Fire Extinguishers (2)	2	100.00	200.00
10	Battery Powered Work Lights	3	50.00	150.00
11	Portable Lantern	1	25.00	25.00
12	Safety Cones	24	25.00	600.00
13	Safety Signs, Stands and Flags	2	100.00	200.00
14	Walkiefialkie Radio	2	300.00	600.00
15	Sand Bags	12	25.00	300.00
16	Tool Kit	1	300.00	300.00
17	Hard Hats	4	50.00	200.00
18	Safety Vests	4	25.00	100.00
19	Equipment Storage Case	4	200.00	800.00
20	Hi Speed Color Camera	4	1,500.00	6,OOO.OO
21	Telephoto Zoom Lens	4	1,200.00	4,800.OO
22	CCU with Genlock	1	600.00	600.00
23	Heavy Duty Tripod with Arm	4	450.00	1,800.00
24	Fluid Pan/Tilt Head	4	300.00	1,200.00
25	Quick Release Plates	4	25.00	100.00
26	Portable Viewfinder (4")	2	300.00	600.00
27	U-Matic "B" VCR	2	4,000.00	8,000.00
28	U-Matic "B" Edit VCR	1	6,500.00	6,500.00
29	Edit Controller	1	1,900.00	1,900.00
30	13" Hi Res monitor, Color	3	500.00	1,500.00
31	Quad B/W Monitor	1	950.00	950.00
32	Quad Split Device, Color	1	2,900.00	2,900.00
33	Special Effects with Dual TBC	1	1 0,000.00	1 0,000.00
34	Video Cable Reels (150')	5	150.00	750.00
35	Video Cable Reels (300')	5	300.00	1,500.00
36	Power Cable Reels (50')	3	25.00	75.00
37	Power Cable Reels (150')	3	50.00	150.00
38	Video Cam-Corder with Case	1	1,500.00	1,500.00
39	Mounting Clamp Set	1	100.00	100.00
40	Wheel Chocks and Ramps	2	50.00	1 00.00
	Total Mobile Vehicle Price			$101 ,1 50.00
	California State Sales Tax			6,827.63
	TOTAL COST OF VAN AND EQUIPMENT			$107,977.62

5.3.2 Personnel

Recording. Two experienced operators are required to set-up and operate the video equipment. The amount of personnel time required to cover one four-hour peak period is roughly sixteen hours, or eight hours for each operator. This includes set-up and tear-down time, as well as the time consumed in traveling to and from the site.

Data Reduction. Data reduction time can vary widely from individual to individual. Current experience in reducing test data suggests that the following ranges apply:

- Personnel time required to identify violators: 2 to 4 hours per hour of videotape
- Personnel time required to identify violators and document vehicle occupancy: 4 to 8 hours per hour of videotape

Personnel Costs. Assuming personnel costs of $30.00 per hour,* the following costs would be incurred in recording and reducing.

	PERSONNEL COST OF RECORDING AND REDUCING FOUR PEAK HOURS OF HOV LANE DATA	
	VIOLATIONS ONLY	VIOLATIONS AND OCCUPANCY
Recording	2 people, 8 hours = 16 hrs @ $30 = $480.00	2 people, 8 hrs = 16 hrs @ $30 = $480.00
Reducing	1 person, 12 hours = 12 hrs @ $30 = $360.00	1 person, 24 hrs = 24 hrs @ $30 = $720.00
Total	28 hrs @ $30 = $840.00	40 hrs @ $30 = $1,200.00

Data reduction costs will drop as trained personnel learn to perform the tasks and become more efficient. Data reduction costs could also be lowered by sampling occupancy rates rather than recording precise occupancy counts for each vehicle during the four hour period.

* This represents the high range of fully loaded costs for ordinary time, and the low range of overtime costs for CALTRANS personnel at the level needed for field observations.

5.3.3 Relative Cost Effectiveness

Enforcement Costs. Although video technology has not yet proven itself capable of supporting a system of mail-out citations, it is instructive to consider the potential cost-effectiveness of such a system. The most promising system identified in the current research would use a video van in combination with a roadside officer to provide the license plate information needed for mailing out citations. Such a system would not replace the routine enforcement activity currently in place on California's mainline lanes, but it might reasonably be expected to replace the overtime assignments needed to augment this routine enforcement.

Concurrent research suggests that a program aimed at ticketing 2.5% of HOV lane violators can be expected to keep overall violation rates within an acceptable 10% level (Billheimer, 1990). There are currently roughly 500 peak commute periods in California each year (two periods during each of 250 weekdays). Covering 2.5% of these periods would require enough personnel to ticket every violator during 12.5 peak periods. However, experience has shown that routine enforcement is responsible for well over half of the citations issued for mainline HOV lane violations in California. Thus special overtime enforcement needs to pick up less than half of the total citations needed, say enough citations for all violators encountered during six peak periods on each project,

The personnel cost of covering a single peak period on one of California's mainline HOV lanes with a combination of video recording and officer observation can be approximated as follows:

One motor officer on overtime	6 hours @ $50/hour =	$300
Van personnel – 2 people	8 hours @ $30/hour =	480
Data reduction – 1 person	12 hours @ $30/hour =	360
Total Personnel Costs		$1,140

Allocating these personnel costs to each of California's ten mainline HOV lanes and allowing for equipment depreciation produces the following annual cost:

Personnel Costs – $1140 x (54 peak periods*) =	$61,560
Equipment Depreciation ($107,977.62 - 4**) =	26,994
	$88,554

* Eight of California's ten mainline lanes operate during both am and pm peaks. Two (SF 280 and LA 91) effectively operate only during one peak, producing a total of 54 peak periods of special enforcement (six for all lanes operating during both peaks, and three each for LA 91 and SF 280.)
Assumes that the equipment is fully depreciated over four years.

Thus the annual costs of supplementing routine enforcement with a system of mail-out citations supported by a combination of video documentation and officer observation would be $88,554. Since the CHP currently allocates at least $334,000 to the special overtime enforcement of HOV lanes, this represents a considerable savings. In addition, a video-based surveillance system would obviate the need for pursuit and citation by special enforcement units during peak commute periods and therefore would be both safer for CHP officers and motorists and less likely to cause congestion than the current approach.

Accordingly it appears that the prospect of video-based enforcement is sufficiently attractive so that the CHP should continue to attempt to develop a system capable of supporting mail-out citations.

Monitoring Costs. The personnel costs of recording and reducing four peak hours of HOV lane data using a three-camera video display have been estimated at $840 if the data reduction activity focuses only on violations, and $1200 if both violations and occupancy are recorded for every car. (See Section 5.3.2.) To these personnel costs must be added an allowance for equipment depreciation. If every mainline HOV lane in California were monitored twice yearly during each peak period, the cost of video monitoring could be computed as follows.

Annual cost of monitoring violations only:

Personnel Costs: $840 x (36 peak periods) =	$30,240	
Equipment Depreciation ($107,977.62 ÷ 4) =	26.994	
		$57,234

Annual cost of monitoring violations and occupancy:

Personnel Costs: $1200 x (36 peak periods) =	$43,200	
Equipment Depreciation	26.994	
		$70,194

On the other hand, the cost of obtaining the same data through manual observation, as it has historically been obtained, is considerably cheaper:

Personnel Time:

On-Site Recording: 2 people x 6 hours =	12 hours
Data Reduction: 1 person x 2 hours =	2 hours
Total	14 hours

Annual Cost of Manual Observation

Personnel Costs: 14 hours x $30/hour x 36 peak periods	$15,120

Thus manual monitoring of HOV lanes is considerably less expensive than videotape monitoring. While these figures are rough estimates, and the annual depreciation charged to mainline HOV lane monitoring could be much less (if, for example the video equipment were applied to other uses such as the surveillance of ramp meter bypass lanes or freeway monitoring in support of air resource board calculations), the personnel costs involved in videotaping lane activity and reducing the taped data will always be at least double the cost of manual observation.

The videotape observations, to be sure, provide far more information than the manual records provided by roadside counters. Videotape provides more accurate records, a consistent data base, and a permanent, verifiable record of traffic activity. It also provides information on the vehicle mix, traffic speeds, and the license plates of violators and carpoolers.

Officials contemplating the use of videotape in monitoring HOV lane performance must ask themselves whether the added benefits provided by the videotaped data are worth the added cost. If the data can be used as a basis for enforcement, of course, the question is moot. As noted earlier, the cost of videotaping and reducing mainline HOV lane data appears to be more than justified if that data can be used as a basis for citing violators and offsetting the need for overtime enforcement activity.

5.4 PUBLIC RELATIONS

In a state in which radar cannot legally be used to enforce speed laws on state freeways, videotape surveillance of HOV lanes has significant legislative and public relations implications. These implications are beyond the scope of the current study. However, two activities occurring during the study may shed some light on the possible reactions of the public and the media to the possibility of videotape surveillance.

(1) In a previous segment of the study (Billheimer, 1990), focus group participants were asked their opinion of a ticket-by-mail system supported by video surveillance.

(2) The field tests undertaken during the current segment of the study attracted the attention of the Los Angeles media and resulted in a limited amount of press coverage.

5.4.1 Focus Group Reactions

During an investigation of HOV lane violations (Billheimer, 1990), six focus group discussions were conducted with drivers on four freeways having HOV lanes: Orange County Route 55 (two groups), Los Angeles Route 91 (two groups); Santa Clara Route 101; and Marin Route 101. These focus groups probed drivers' perceptions of and attitudes toward HOV lanes, violations, and enforcement activities. In five of the six focus groups, the possibility of video surveillance and tickets-by-mail was suggested by members of the group. At the close of all six group discussions, this possibility was outlined and participants were asked their opinion of the concept. Discussions were invariably heated, with strong feelings on either side of the issue. In the end, participants in three focus groups favored using mail-out citations, while participants in the three remaining groups were opposed. A summary of the arguments for and against the concept appears below:

(1) **Arguments For.** One OR 55 driver noted that "Mail-out tickets is the best way (to enforce HOV lanes). Pulling violators over is almost out of the question...It really messes up the traffic pattern." Another OR 55 driver felt that mail-out tickets would "...free police for more important duties. But that doesn't mean the CHP should disappear. That visibility is important." Several drivers made the point that before mailing out tickets, the state "... needs to educate the public first." The public needs to understand both the need for compliance with HOV regulations and, in particular, the need for video surveillance.

(2) **Arguments Against.** "Shades of Big Brother" was the most frequently cited argument against mail-out citations. Many drivers expressed concern over the technological problems involved in making sure that the camera hadn't missed a baby or a sleeping adult. Even when the majority of the group favored mail-out tickets, there was generally a vocal minority which felt strongly that they were an invasion of privacy.

In short, driver opinion split dramatically on the desirability of videotape surveillance and tickets-by-mail. Opponents cited "big-brotherism" while proponents argued that freeway ticketing caused significant traffic slowdowns. Most drivers agreed that the public would have to be educated regarding the need both for HOV lanes and mail-out citations if such a procedure were to succeed.

5.4.2 Press Coverage

The Los Angeles Times took an interest in the videotape tests and sent a reporter and cameraman to the Warner Avenue overcrossing on the day of the final field test. The reporter,

Eric Bailey, interviewed most of the participants in the test, as well as representatives from the Orange County based Drivers for Highway Safety. The text of Bailey's story, which ran in the Although the story predictably raised the specter of Times on January 9, appears In Appendix B. Big Brother, it was balanced and informative, and has evidently generated remarkably little negative reaction. A follow-up piece by John Rezendes-Herrick of the Daily Report/Progress Bulletin in Ontario, California was similarly balanced (see Appendix B). To the extent that these stories can be viewed as an indication of press and public reaction to the use of videotape in HOV lane enforcement, there was no suggestion that CALTRANS and the CHP would be exposed to a massive public outcry if videotape proves to be technologically and legally feasible as an enforcement tool. Furthermore, it can be assumed that the articles themselves made potential HOV lane violators in the Los Angeles area more cautious.